DEPARTMENT OF THE ARMY
TECHNICAL MANUAL

TM 11-5500

DEPARTMENT OF THE
AIR FORCE MANUAL

AFM 101-10

MULTIMETER

TS-297/U

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
AUGUST 1948

TM 11-5500 ——— AFM 101-10

MULTIMETER

TS-297/U

United States Government Printing Office
Washington : 1948

CONTENTS

DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment.

WHEN — When ordered by your commander.

HOW —

1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.
2. Cut—Use axes, handaxes, machetes.
3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.
4. Explosives—Use firearms, grenades, TNT.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT —

1. Smash—Meter, knobs, switches, cabinet.
2. Cut—Cables, wiring.
3. Burn—Technical manuals schematic diagrams, cabinet, cables, wiring.
4. Bend—Panel.
5. Bury or scatter—All of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

SAFETY NOTICE

DANGEROUSLY HIGH VOLTAGES ARE PRESENT IN RADIO AND OTHER ELECTRONIC EQUIPMENT AND ASSOCIATED POWER SUPPLIES.

AVOID CONTACT WITH HIGH-VOLTAGE CIRCUITS OR A-C INPUT CONNECTIONS IN SUCH EQUIPMENT, AND BE SURE THAT POWER IS TURNED OFF BEFORE DISASSEMBLING THE EQUIPMENT.

BEFORE MAKING ANY SERVICE CHECKS, MANUALLY DISCHARGE ALL HIGH-VOLTAGE CAPACITORS IN POWER SUPPLY CIRCUITS AFTER A-C POWER HAS BEEN REMOVED FROM COMPONENTS.

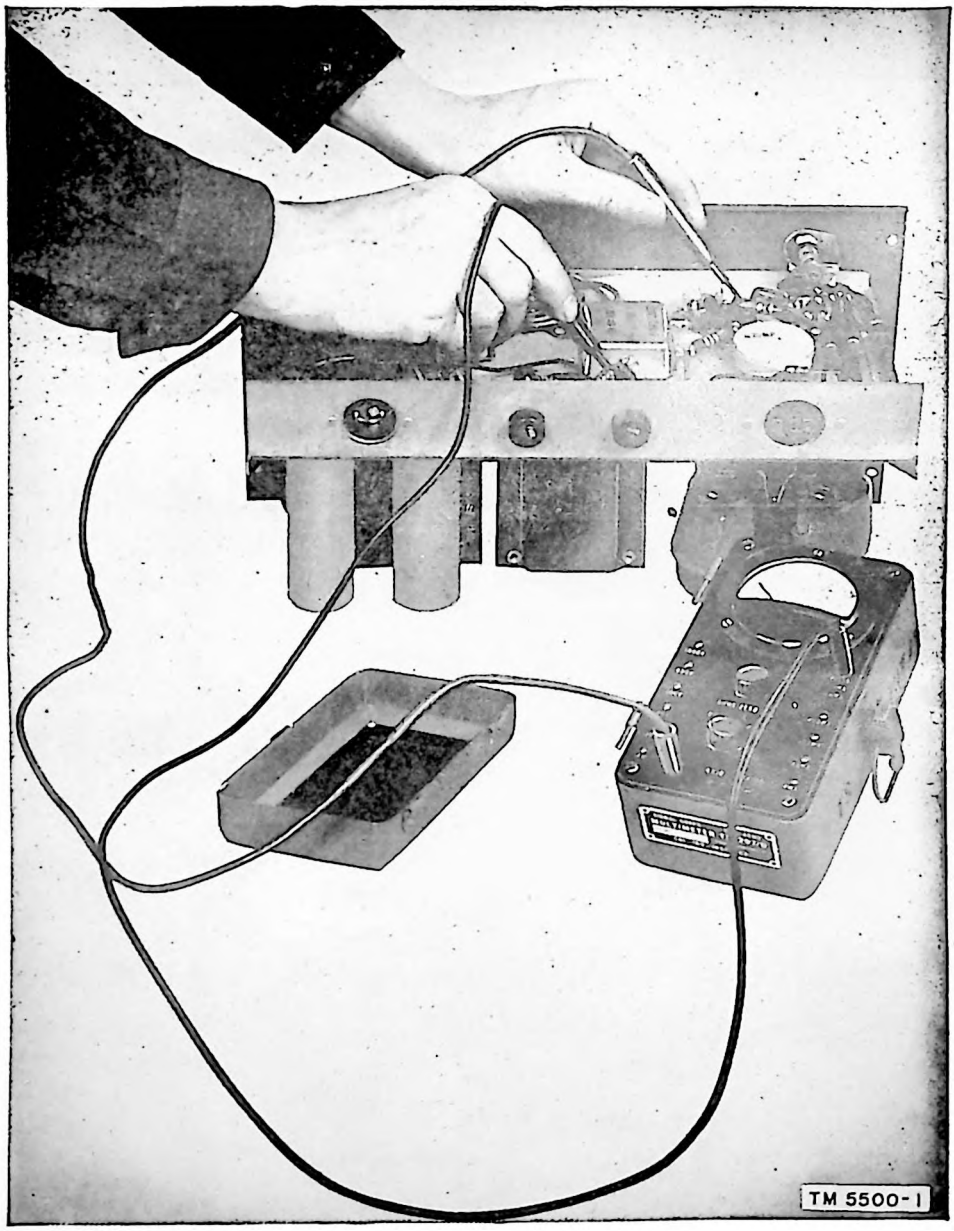


Figure 1. Multimeter TS-297/U in use.

PART ONE

INTRODUCTION

Section I. DESCRIPTION

1. General

Multimeter TS–297/U is a multirange test instrument for measuring voltage, direct current, and resistance. It is designed primarily for use in the maintenance and repair of electronic equipment but may be used to check any voltage, current, or resistance within its range (par. 2). With the addition of a capacitor (par. 18), it may also be used as an output meter.

2. Technical Characteristics

Voltage ranges [a-c (alternating-current) and d-c (direct-current), 1,000 ohms per volt]. 0 to 4 v (volts)
0 to 10 v
0 to 40 v
0 to 100 v
0 to 400 v
0 to 1,000 v

Direct-current ranges ..... 0 to 4 ma (milliamperes)
0 to 40 ma
0 to 100 ma
0 to 400 ma

Resistance ranges ..... 0 to 1,000 ohms
0 to 10,000 ohms
0 to 100,000 ohms

Output ranges ..... Same as voltage ranges.

Power source for resistance measurements... One Battery BA–42, 1.5 v.

Accuracies				
Temperature (C)	Temperature (F)	All d-c ranges (%)	All a-c ranges (%)	All ohm ranges (%)
+25°	+ 77°	±3	±5	±3
−40°	− 40°	±6	±8	.....
+55°	+131°	±5	±6	±5

3. List of Components

a. EQUIPMENT SUPPLIED. The following table gives the physical measurements of components supplied with the equipment:

Quantity	Name of Component	Dimensions (in.)				Unit weight (lb)	Unit volume (cu in.)
		Height	Width	Depth	Length		
1	Multimeter	6⅛	3¼	3¼	.....	2⅜	64.6
2	Cord CX–529/U (including 2 clips, Mueller No. 60).	.....	.....	.....	48		
1	Cord CX–468/U	.....	.....	.....	48		

Note. This list is for general information only. See appropriate publications for information pertaining to requisition of spare parts.

b. EQUIPMENT REQUIRED BUT NOT SUPPLIED. 1 Battery BA–42, 1.5 v.

4. Packaging Data

Packed for export shipment (fig. 4), Multimeter TS–297/U is contained in a heavy cardboard carton 7½ inches long, 5½ inches wide, and 4½ inches high. The volume of the carton is 186 cubic inches, and the shipping weight is 3 pounds, 5 ounces.

5. Description of Components (fig. 2)

a. MULTIMETER. The multimeter consists of a meter and various other electrical components mounted on a black bakelite panel inclosed in a metal case. The case also contains a battery holder.

(1) *Panel* (fig. 3). All electrical components of the unit except the battery holder are mounted on the under side of the panel. On the face of the panel are a meter dial, 2 knobs, and 14 pin jacks.

(a) Meter dial. The meter dial is white and is marked with three scales which are calibrated along parallel arcs. The upper scale labeled DC, is printed in black and graduated for the measurement of d-c volts and milliamperes. Every fifth division is marked above the scale, and markings are in alternative series of numerals: 0 (common); 10, 20, 30, 40; and 25, 50, 75, 100. The center scale, labeled OHMS, is printed in green. Divisions are marked below the scale from zero to infinity by numerical designations: 0, 5, 10, 20, 30, 50, 100, 200, 500, 1,000, ∞. The lower scale, labeled ACV, is printed in red, and every fifth division is marked below the scale by alternative series of numerals: 0 (common); 10, 20, 30, 40; and 25, 50, 75, 100.

(b) Knobs. A rheostat knob labeled OHMS ZERO ADJ and a switch knob labeled OHMS AC DC are located below the meter dial on the panel face.

(c) Jacks. There are six voltage-range jacks, labeled 1,000V, 400V, 100V, 40V, 10V, and 4V; three resistance-range jacks, labeled RX1,

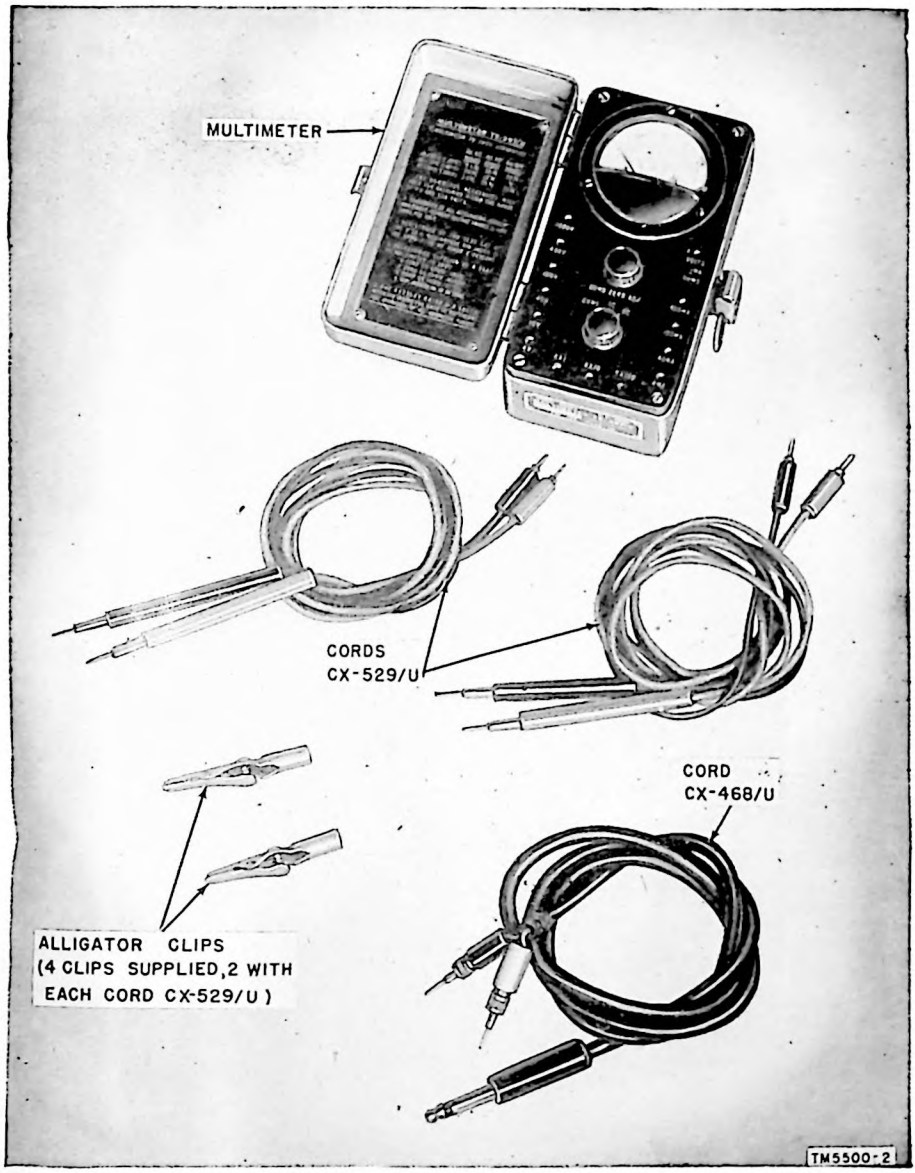


Figure 2. Multimeter TS–297/U, components.

RX10, and RX100; four d-c range jacks, labeled 4MA, 40MA, 100MA, and 400 MA; and one common jack labeled ± VOLTS — MA OHMS.

(2) *Case.* The case is aluminum and has a removable hinged lid fastened by a latch. A battery holder is located inside at one end of the bottom of the case (fig. 5). Brackets are provided at the corners for mounting the panel.

b. Cord CX–529/U. Cord CX–529/U consists of two separate, single-conductor, rubber-jacketed test leads, one red and one black, each

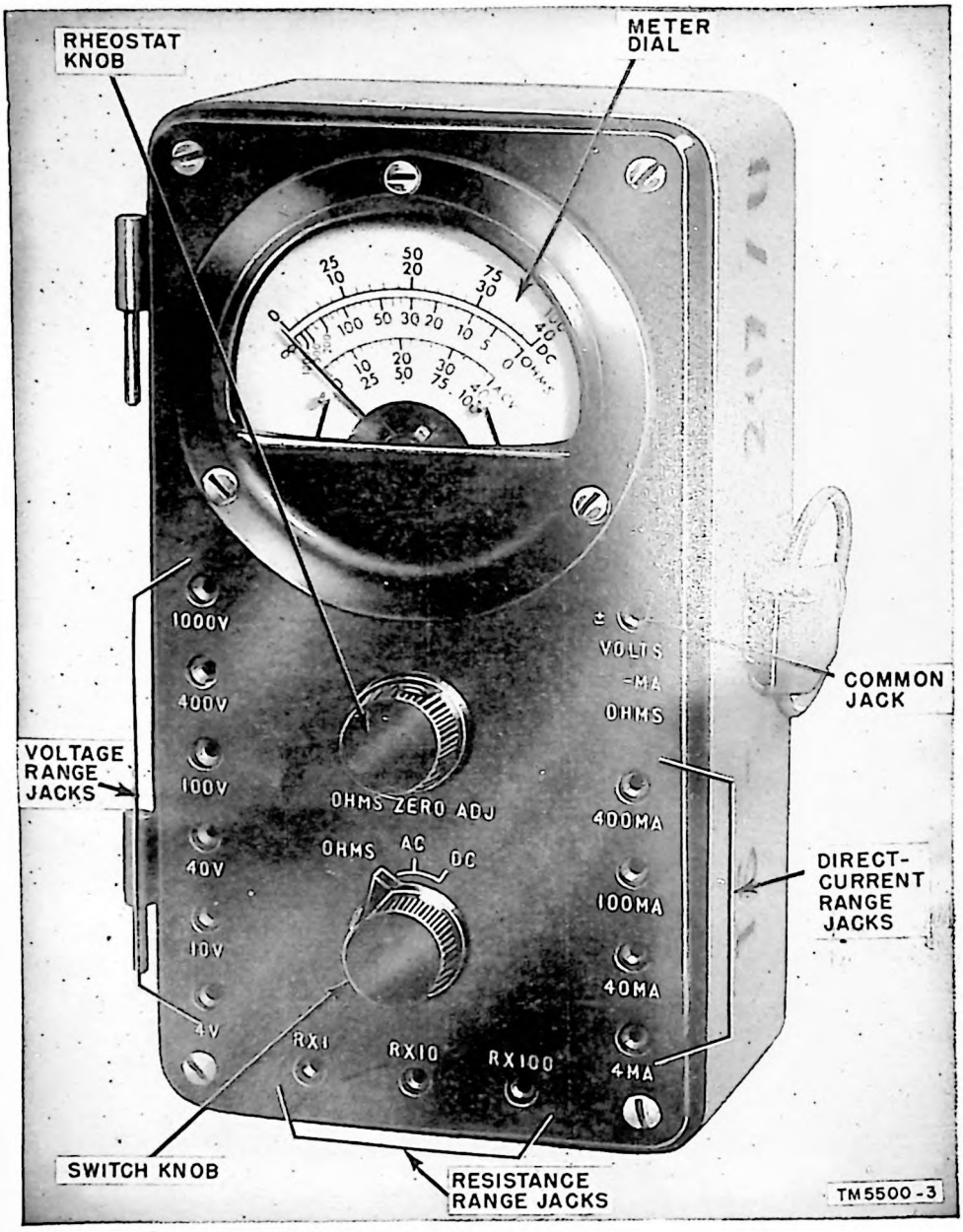


Figure 3. Multimeter, view of panel face.

terminating in a telephone tip at one end and a test prod at the other. An alligator clip (Mueller No. 60) is supplied for use with each test lead.

c. Cord CX–468/U. Cord CX–468/U is a two-conductor, rubber-jacketed length of cordage which terminates at one end in two telephone tips, one red-insulated and one black-insulated, and at the other end in Plug PL–55.

Section II. INSTALLATION AND ASSEMBLY

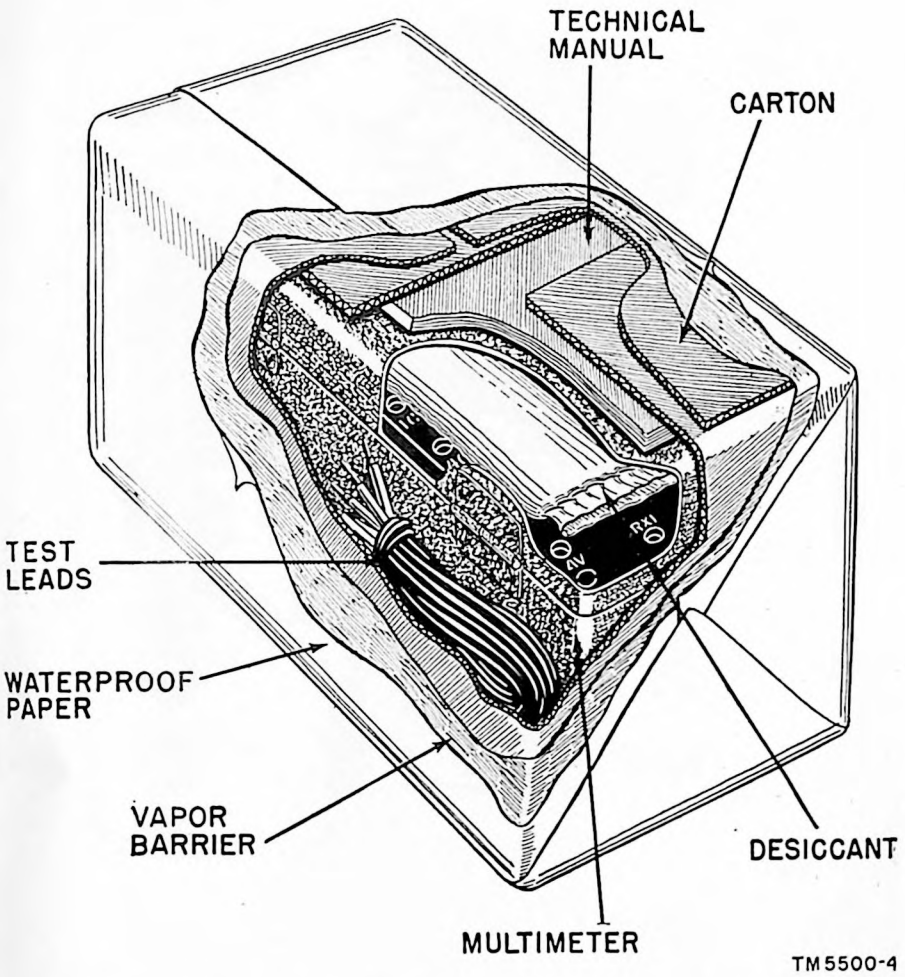


Fig. 4. Multimeter TS-297/U, cutaway view showing packaging details.

6. Unpacking and Checking (fig. 4)

a. UNPACKING. (1) Remove outer wrapping of waterproof paper.

(2) Cut off sealed edge of vapor barrier and remove carton from barrier. If cut carefully, vapor barrier may be used again.

(3) Open carton and remove multimeter and cords.

(4) Unlatch and lift lid of multimeter and remove silica gel bag (desiccant).

b. CHECKING. (1) Inspect multimeter and cords carefully for damage.

(2) Check components against list given in paragraph 3*a*.

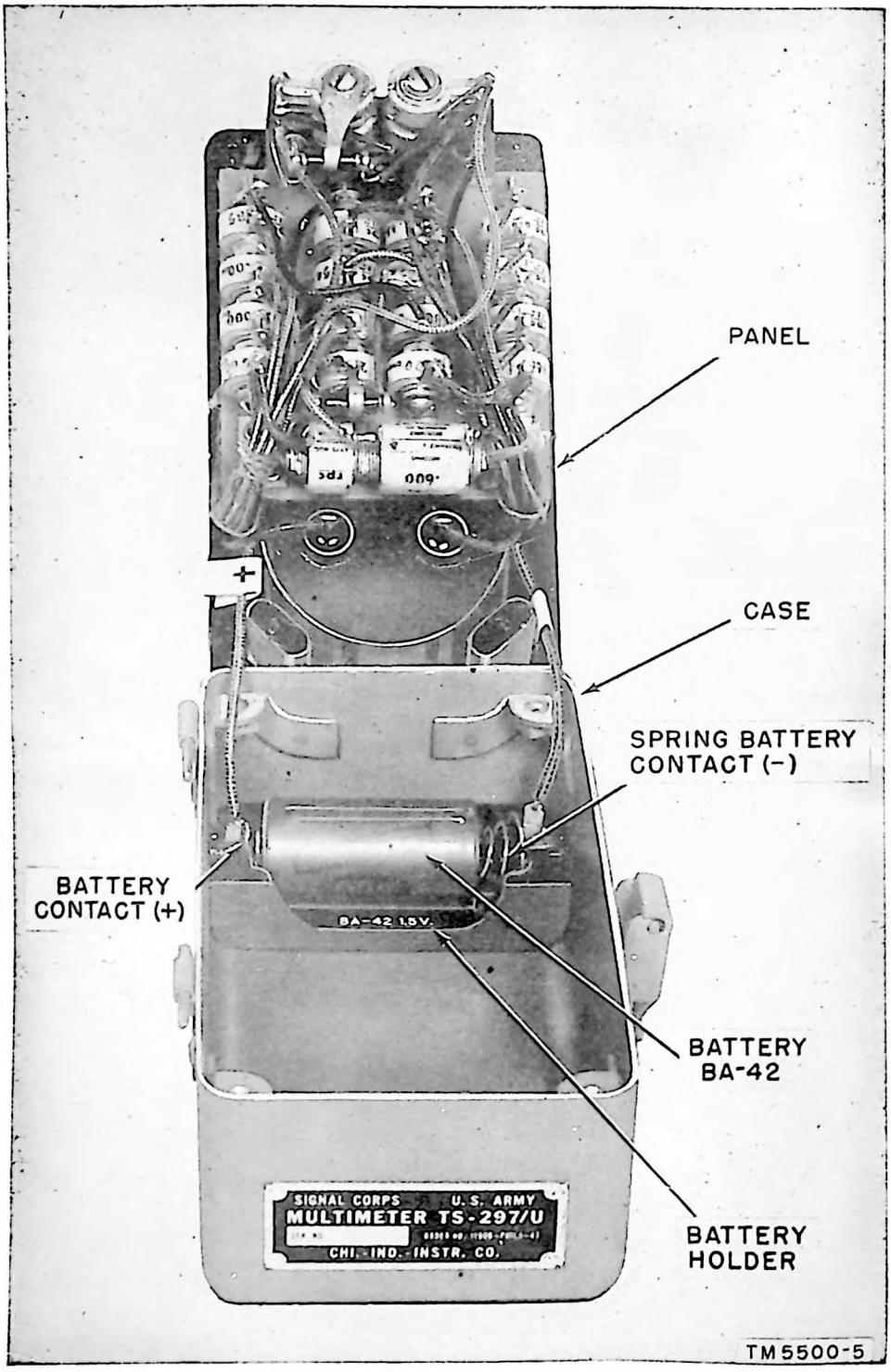


Figure 5. Multimeter, panel raised for installation of battery.

7. Installation (fig. 5)

Install Battery BA–42 as follows:

a. Release latch on side of case; lift lid and slide it from slip hinges to separate it from case.

b. Remove the four corner screws that hold instrument panel to case.

c. Raise panel slowly from case, being careful not to strain the two leads which connect panel to battery holder.

d. Place bottom (—) of battery against end of spring battery holder and press until top of battery slips into place against contact at opposite end of holder. *Be sure that battery is firmly seated against both contacts.*

e. Replace panel in case and check battery installation as follows:

(1) Set OHMS AC DC switch at OHMS position.

(2) Insert tip of red test lead (Cord CX–529/U) in RX1 jack and tip of black test lead in common jack.

(3) Touch tips of test prods together. Meter needle should swing to right if battery is installed correctly.

(4) Turn OHMS ZERO ADJ rheostat knob to the right. Meter needle should go beyond right zero if battery voltage is high enough.

f. Screw panel in place. Multimeter is now ready for use.

8. Removal from Service

When the multimeter is not in use, remove all test leads and close and latch the lid. Wrap the test leads neatly and place them with the multimeter. If the multimeter is not to be used for a period exceeding 30 days, remove the battery.

PART TWO

OPERATION INSTRUCTIONS

Section III. CONTROLS AND THEIR USE

9. Ohms Zero ADJ Knob (fig. 3)

The OHMS ZERO ADJ rheostat knob is used to calibrate the meter for resistance measurements. This control compensates for circuit differences among the three resistance ranges and for voltage changes due to battery deterioration.

10. Ohms AC DC Knob (fig. 3)

The OHMS AC DC switch knob, which has three positions, connects various combinations of electrical components as required to measure resistance, voltage, or current.

11. Jacks (fig. 3)

The pin jacks permit connection of test lead tips with various multimeter circuits. The common jack is used in making all measurements. The 4V to 1,000V jacks control circuits for a-c and d-c voltage measurements; the RX1 to RX100 jacks, for resistance measurements; and the 4MA to 400MA jacks, for d-c measurements.

12. Cords (fig. 2)

Cords CX–529/U and CX–468/U are used to connect appropriate multimeter jacks with the circuit or component to be tested. Cord CX–529/U is used when it is necessary to apply test prods directly to the circuit to be measured. Cord CX–468/U may be used whenever current or voltage to be measured is accessible through a jack which will accommodate Plug PL–55.

Section IV. OPERATION

13. Preoperational Procedures

Before attempting to operate the multimeter, make the following preoperational checks:

a. Place the multimeter horizontally (fig. 1) and observe the meter. The pointer should rest over both left zeros when viewed from directly above.

b. Rotate the OHMS ZERO ADJ knob to left and right. No friction or binding should be apparent in the movement, and the angle of rotation should be about 270°.

c. Rotate OHMS AC DC switch to OHMS, AC, and DC positions. The pointer should move from one position to another without binding.

d. Avoid mechanical shock to the multimeter. Such shock may result in permanent damage to the meter movement.

14. High-voltage Precautions

High voltages are dangerous and may be fatal. When measuring voltages greater than 100 volts, proceed as follows:

a. Connect a ground lead to the multimeter panel.

b. Place one hand in back pocket to avoid making accidental contact with either the ground lead or another part of the circuit.

c. Shut off power in the equipment under test.

d. Attach test prods across circuit to be measured.

e. Step away from the multimeter and turn on power in equipment under test.

f. Note reading on the multimeter dial *without touching any part of the multimeter.*

g. Shut off power in equipment under test before disconnecting test prods or touching the multimeter.

15. Measuring Voltage

Make voltage measurements with power on in the circuit under test. To measure voltage, proceed as follows:

a. Turn OHMS AC DC switch to AC, if a-c voltage is to be measured; or to DC, if d-c voltage is to be measured.

b. Insert tip of black test lead (Cord CX–529/U) in common jack and tip of red test lead in appropriate jack for voltage to be measured. Use jacks as follows:

Range (v)	*Jack*
0 to 4	4V
0 to 10	10V
0 to 40	40V
0 to 100	100V
0 to 400	400V
0 to 1,000	1,000V

c. Place test prods in parallel with circuit to be tested.

d. Read d-c voltage on DC scale of meter and a-c voltage on AC scale

as follows: (If meter needle moves backwards when measuring d-c voltage, reverse test-lead connections.)

Range (v)	*Reading (v)*
0 to 4	Read directly by 0 to 40 series and divide reading by 10.
0 to 10	Read directly by 0 to 100 series and divide reading by 10.
0 to 40	Read directly by 0 to 40 series.
0 to 100	Read directly by 0 to 100 series.
0 to 400	Read directly by 0 to 40 series and multiply reading by 10.
0 to 1,000	Read directly by 0 to 100 series and multiply reading by 10.

Note. Determine appropriate range for voltage to be measured by first using the 1,000V range to obtain an approximate reading; then use the lowest possible range as indicated by the reading.

16. Measuring Direct Current

Caution: Shut off power of equipment under test before making connections for current measurements. The meter has low resistance and will burn out if connected in parallel with a circuit.

Make current measurements with power on in the equipment under test. Never test a dry battery using the multimeter as a milliammeter, because the battery will be short-circuited and the meter may be burned out. To measure direct current, proceed as follows:

a. Turn OHMS AC DC switch to DC.

b. Insert tip of black test lead (Cord CX–529/U) in common jack and tip of red test lead in appropriate jack for current to be measured. Use jacks as follows:

Range (ma)	*Jack*
0 to 4	4MA
0 to 40	40MA
0 to 100	100MA
0 to 400	400MA

c. Apply test prods in series with circuit to be measured.

Caution: If there is danger that the current to be measured is not within limits of the multimeter, touch test prods to circuit lightly and withdraw them immediately. Meter needle should not go off scale if current is within limits of the multimeter.

d. Read direct current on DC scale as follows:

Range (ma)	*Reading (ma)*
0 to 4	Read directly by 0 to 40 series and divide reading by 10.
0 to 40	Read directly by 0 to 40 series.
0 to 100	Read directly by 0 to 100 series.
0 to 400	Read directly by 0 to 40 series and multiply reading by 10.

Note. Determine appropriate range for direct current to be measured by first

using the 400MA range to obtain an approximate reading; then use the lowest possible range as indicated by the reading.

17. Measuring Resistance and Testing Continuity

Caution: Shut off power in circuit under test before making resistance measurements or testing continuity.

Proceed as follows:

a. Turn OHMS AC DC switch to OHMS position.

Caution: Do not leave the switch on OHMS when multimeter is not in use and test-lead tips are inserted, because accidental shorting of test prods will result in a drain on the battery.

b. Insert tip of black test lead (Cord CX–529/U) in common jack and tip of red test lead in appropriate RX jack. In testing continuity, use RX1 jack if known resistance is low, or higher range RX jack if known resistance is high. Use jacks as follows:

Range (ohms)	*Jack*
0 to 1,000	RX1
0 to 10,000	RX10
0 to 100,000	RX100

c. Hold test prods together and rotate OHMS ZERO ADJ control to left and right until meter needle rests exactly over 0 on the green scale when viewed from directly above. Separate test prods. (Readjust the control as necessary when changing from one resistance range to another. When it becomes impossible to secure a zero reading on the meter by adjusting the control, replace the battery according to instructions in par. 7.)

d. To measure resistance—

(1) Examine a schematic which includes resistance to be tested and determine whether any of the resistors concerned shunt some part of a circuit. Disconnect any such resistor before taking a reading. Do not disconnect components for general circuit resistance measurements.

(2) Place test prods across the resistance to be measured.

(3) Read resistance measurements on green scale as follows:

Range (ohms)	*Reading (ohms)*
0 to 1,000	Read scale directly.
0 to 10,000	Read scale directly and multiply reading by 10.
0 to 100,000	Read scale directly and multiply reading by 100.

e. To test continuity—

(1) Touch test prods to ends of circuit under test.

(2) The circuit is open if the meter needle does not move. Continuity, or a closed circuit, is indicated if the needle shows zero resistance.

Note. Determine the appropriate range for resistance to be measured by first

using the RX100 range to obtain an approximate reading; then use the lowest possible range as indicated by the reading.

18. Measuring Output

To use this multimeter as an output meter, connect in series with either test lead a 0.1 mf (microfarad) capacitor that has a voltage rating exceeding the voltage in the circuit under test. Then proceed as follows:

a. Turn OHMS AC DC switch to AC.

b. Insert tip of black test lead (Cord CX–529/U) in common jack and tip of red test lead in appropriate voltage jack for circuit of which output is to be measured. Connect test prods across output circuit of equipment to be tested. Use multimeter jacks in accordance with paragraph 15*b*.

c. Read voltage on red scale, labeled ACV, in accordance with paragraph 15*d*.

d. Determine the exact output value by using table I, decibel conversion.

19. Testing for Shorted Capacitors

To detect shorted capacitors, proceed as follows:

a. Examine a schematic including the capacitor to be tested and determine whether the capacitor is shunted by some part of the circuit. Disconnect shunted capacitors before testing.

b. Turn OHMS AC DC switch to OHMS position.

c. Insert tip of black test lead (Cord CX–529/U) in common jack nd tip of red test lead in RX1 jack.

d. Place test prods across capacitor to be tested. If the capacitor is shorted, the meter needle will point to 0 or near 0. If the capacitor is not shorted, a very high or infinite resistance will be indicated. When a capacitor is over 0.25 mf, the meter needle should kick up as soon as the multimeter is connected on RX100. Similar kicks should be observed after the test leads have been reversed and reconnected.

Caution: Do not leave switch at OHMS position when multimeter is not in use and the test lead tips are inserted, because accidental shorting of test prods will result in a drain on the battery.

Table I. Decibel Conversion

db	Volts		Volts		Volts	
	500 ohms	500 ohms	600 ohms	600 ohms	1,500 ohms	1,500 ohms
	1 mw	6 mw	1 mw	6 mw	1 mw	6 mw
−10	0.22	0.55	0.25	0.60	0.39	0.95
−9	0.25	0.61	0.28	0.67	0.44	1.06
−8	0.28	0.69	0.31	0.76	0.49	1.19
−7	0.32	0.77	0.35	0.85	0.55	1.34
−6	0.35	0.87	0.39	0.95	0.61	1.50
−5	0.40	0.97	0.44	1.07	0.69	1.69
−4	0.45	1.09	0.49	1.20	0.77	1.89
−3	0.50	1.23	0.55	1.34	0.87	2.12
−2	0.56	1.38	0.62	1.51	0.97	2.38
−1	0.63	1.54	0.69	1.69	1.09	2.67
0	0.71	1.73	0.78	1.90	1.23	3.00
1	0.79	1.94	0.87	2.13	1.37	3.37
2	0.89	2.18	0.98	2.39	1.54	3.78
3	1.00	2.45	1.09	2.68	1.73	4.24
4	1.12	2.75	1.22	3.01	1.94	4.76
5	1.26	3.08	1.38	3.37	2.18	5.33
6	1.41	3.46	1.55	3.78	2.44	5.99
7	1.58	3.88	1.73	4.25	2.74	6.72
8	1.78	4.35	1.95	4.77	3.08	7.54
9	1.99	4.88	2.18	5.35	3.45	8.45
10	2.24	5.48	2.45	6.00	3.87	9.49
11	2.50	6.15	2.75	6.73	4.35	10.64
12	2.81	6.90	3.08	7.55	4.88	11.94
13	3.16	7.73	3.46	8.47	5.47	13.40
14	3.54	8.68	3.88	9.51	6.14	15.03
15	3.98	9.74	4.35	10.67	6.89	16.86
16	4.46	10.92	4.88	11.97	7.73	18.93
17	5.00	12.26	5.48	13.43	8.67	21.23
18	5.62	13.76	6.15	15.07	9.73	23.83
19	6.30	15.43	6.90	16.91	10.91	26.73
20	7.07	17.32	7.75	18.97	12.25	30.00
21	7.93	19.43	8.69	21.28	13.74	33.66
22	8.90	21.80	9.75	23.88	17.30	37.77
23	10.00	24.47	10.94	26.80	15.42	42.39
24	11.20	27.45	12.27	30.06	19.41	47.55
25	12.57	30.79	13.77	33.73	21.78	53.34
26	14.10	34.55	15.45	37.85	24.43	59.85
27	15.82	38.77	17.34	42.47	27.42	67.17
28	17.75	43.50	19.45	47.65	30.77	75.36
29	19.92	48.80	21.82	53.46	34.52	84.54
30	22.35	54.76	24.49	59.98	38.73	94.86
31	25.08	61.45	27.48	67.31	43.46	106.44
32	28.14	68.95	30.83	75.51	48.76	119.43
33	31.58	77.36	34.60	84.73	54.72	134.01
34	35.43	86.80	38.82	95.08	61.39	150.36
35	39.75	97.39	43.56	106.67	68.88	168.69
36	44.61	109.28	48.88	119.70	77.29	189.30
37	50.04	122.60	54.83	134.29	86.71	212.37
38	56.15	137.57	61.52	150.68	97.30	238.29
39	63.01	154.37	69.04	169.08	109.18	267.39
40	70.70	173.20	77.46	190.50	122.50	300.00

PART THREE

MAINTENANCE INSTRUCTIONS

Section V. PREVENTIVE MAINTENANCE

20. Meaning

PM (preventive maintenance) is a series of operations performed on equipment at regular intervals to eliminate major break-downs and interruptions in service and to keep the equipment at optimum operating efficiency. The prime function of PM is to *prevent* break-downs and the need for repair; whereas the prime function of trouble shooting and repair is to *locate* and *correct* existing defects. Keep Multimeter TS–297/U in proper operating condition, because the operation and efficiency of an entire communications system may depend on test equipment.

21. Techniques

Most of the parts used in Multimeter TS–297/U require routine PM. Do not apply hit-or-miss maintenance techniques; definite and specific instructions are needed. The most important operation in a PM program is inspection. Carefully observe all parts of the equipment, noting color, placement, state of cleanliness, and tightness. Be sure that all parts and connections are free of dust, corrosion, and other foreign matter. Never tighten screws and nuts carelessly; fittings tightened beyond the pressure for which they were designed will be damaged or broken.

22. Tools and Materials

The following PM tools and materials are needed:

Common hand tools
Clean cloth
Solvent, dry cleaning (SD)
Polish, metal, paste (Sig C stock No. 6G1516)

23. Multimeter Exterior (Weekly)

a. PANEL. (1) Rotate OHMS ZERO ADJ and OHMS AC DC knobs. If either is loose, tighten appropriate setscrew with Allen wrench.

(2) Inspect pin jack openings. If they are clogged with foreign matter, such as sand, dirt, snow, or ice, remove obstructions by probing with a fine wire or by blowing with an air hose.

(3) Check the three meter screws and the four corner mounting screws for tightness.

(4) If meter glass has not been fungiproofed, clean it with a cloth dampened in alcohol or water. If the glass has been fungiproofed, see paragraph 26.

(5) If engraved labels on the panel have become indistinct, use a small brush to fill in the characters with white or cream wiping enamel. After enamel has hardened for several hours, wipe off excess with a cloth moistened in thinner or solvent (SD).

b. CORDS. (1) Check cords for loose connections, worn rubber jacketing, or metal corrosion. Examine particularly the insulation where the cord enters the test prod. Damaged insulation may cause shock to the operator.

(2) Tighten loose connections, bind with friction tape or replace any badly worn sections of rubber jacketing, and clean metal parts with paste metal polish.

24. Multimeter Interior (Monthly)

a. PRELIMINARY PROCEDURE. (1) Remove the four screws that hold panel to case.

(2) Remove the two screws that connect wires to battery holder at points marked + and —.

(3) Remove panel from case.

b. MAINTENANCE PROCEDURE. (1) If necessary, tighten the three bolts which hold the resistors together in banks.

(2) Inspect all wiring for loose connections and frayed insulation. Whenever a new connection is made, carefully clean varnish around the solder joint before resoldering. Then moistureproof and fungiproof the joint by applying varnish with a small brush (par. 26).

(3) Dust interior of case with a clean cloth.

(4) Using the two screws that were removed (*a*(2) above), reconnect the two wires leading from panel to battery holder. Be sure that wire labeled + is attached to + end of battery holder and wire labeled — to — end.

(5) Replace panel in case and replace and tighten the four panel screws.

(6) Check battery installation (par. 7*e*). Replace battery if voltage is lower than 1.25 volts.

Section VI. LUBRICATION

(Not required.)

Section VII. WEATHERPROOFING

25. General

Signal Corps equipment, when operated under the severe climatic conditions which prevail in the tropic, Arctic, or desert regions, requires special treatment and maintenance.

26. Tropicalization

a. GENERAL. Because fungus growth, insects, corrosion, salt spray, and excessive moisture affect most materials harmfully, a special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. See TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing and the supplies and equipment required for treatment. The following problems may be encountered:

(1) Resistors, coils, etc., fail because of the effects of fungus growth and excessive moisture.

(2) Electrolytic action, often visible in the form of corrosion, takes place in resistors, coils, etc., causing eventual break-down.

(3) Hook-up wire insulation and cable insulation break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical paths on terminal boards and insulating strips causing flash-overs.

Caution: Varnish spray may have poisonous effects if inhaled. To avoid inhaling spray, use a respirator if one is available; otherwise, fasten cheesecloth or other cloth material over nose and mouth. Never spray varnish or lacquer near an open flame. Do not smoke in a room where varnish or lacquer is being sprayed; the spray may be highly explosive.

b. MULTIMETER TS–297/U. This instrument is treated in production to provide protection from moisture and fungus under humid or tropical operating conditions.

c. MOISTUREPROOFING AND FUNGIPROOFING AFTER REPAIRS. If the coating of protective varnish has been punctured or broken during repair, and if a complete treatment is not needed to reseal the equipment, apply a brush coat of varnish to the affected part. Be sure the break is completely sealed.

27. Winterization

a. GENERAL. Most signal equipment can be used in winter if precautions are taken to prevent difficulties common in low temperatures. For operation purposes, place equipment in heated rooms whenever possible. When on the march, wrap equipment in blankets to protect it from winds and freezing temperatures. See TB SIG 66, Winter Maintenance of Signal Equipment, for complete information. The following problems may be encountered:

(1) Steel shrinks and becomes brittle in subzero temperatures.

(2) Glass is especially susceptible to sudden temperature changes. The difference between a low air temperature and the warmth of a man's breath may be sufficient to shatter a lens.

(3) Natural rubber resists cold weather well, but certain types of synthetic rubber are unreliable and become brittle.

b. MULTIMETER TS–297/U. This instrument will perform satisfactorily under low-temperature operating conditions. However, when the temperature is extremely low, make provision to protect the multimeter so that the battery will not fail and prevent use of the ohmmeter ranges. If possible, when the temperature is very low and the multimeter is not in use, remove the battery and store it in an inner shirt pocket or another warm place.

28. Dustproofing

Signal Corps equipment operated in desert localities is affected by the extremely high temperatures and the amount of dirt, dust, sand, and other foreign matter in the air. Thorough cleanliness of Multimeter TS–297/U is imperative. Keep the lid closed when equipment is not in use. If possible, clean exterior of the panel and case daily. See TB SIG 75, Desert Maintenance of Ground Signal Equipment.

PART FOUR

AUXILIARY EQUIPMENT

(Not used.)

PART FIVE

REPAIR INSTRUCTIONS

Section VIII. THEORY OF EQUIPMENT

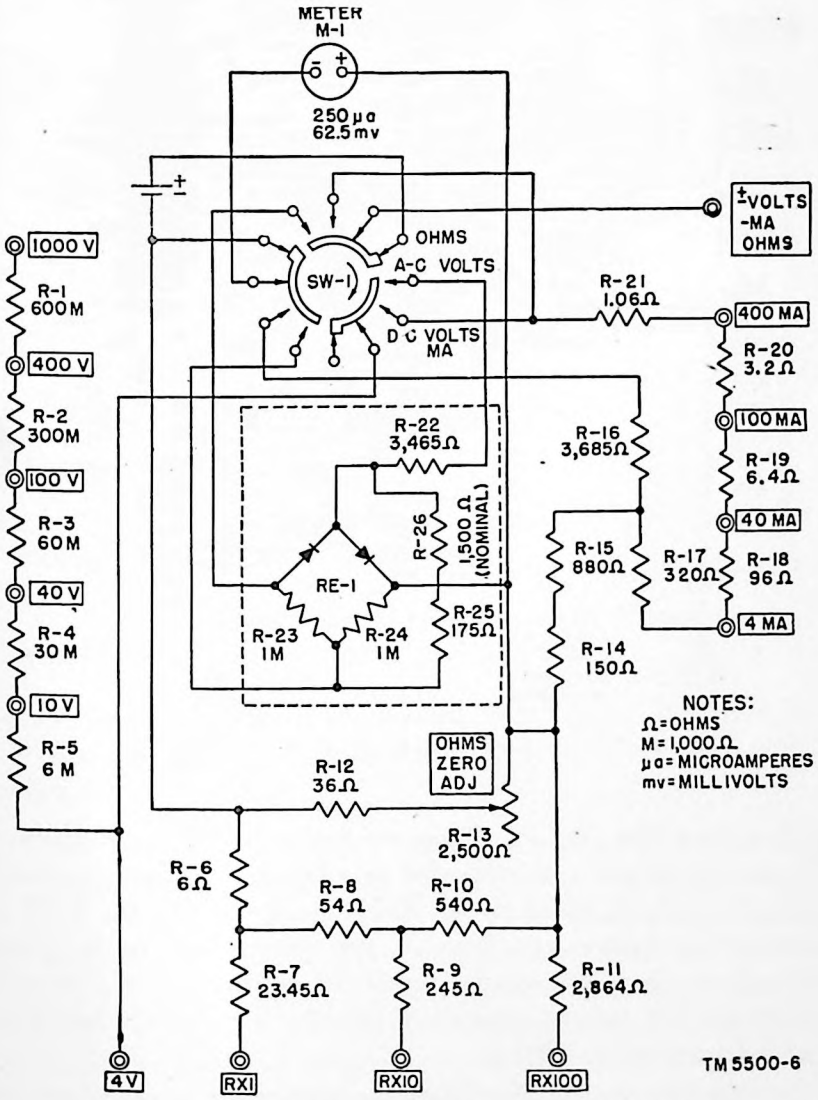


Figure 6. Multimeter TS-297/U, schematic diagram.

29. General Theory (fig. 6)

Various combinations of series and shunt resistors are used in connection with the meter to measure voltage, current, and resistance over a number of different ranges. The following subparagraphs and related schematics will facilitate repair work by showing only those components actively concerned in the circuit under examination.

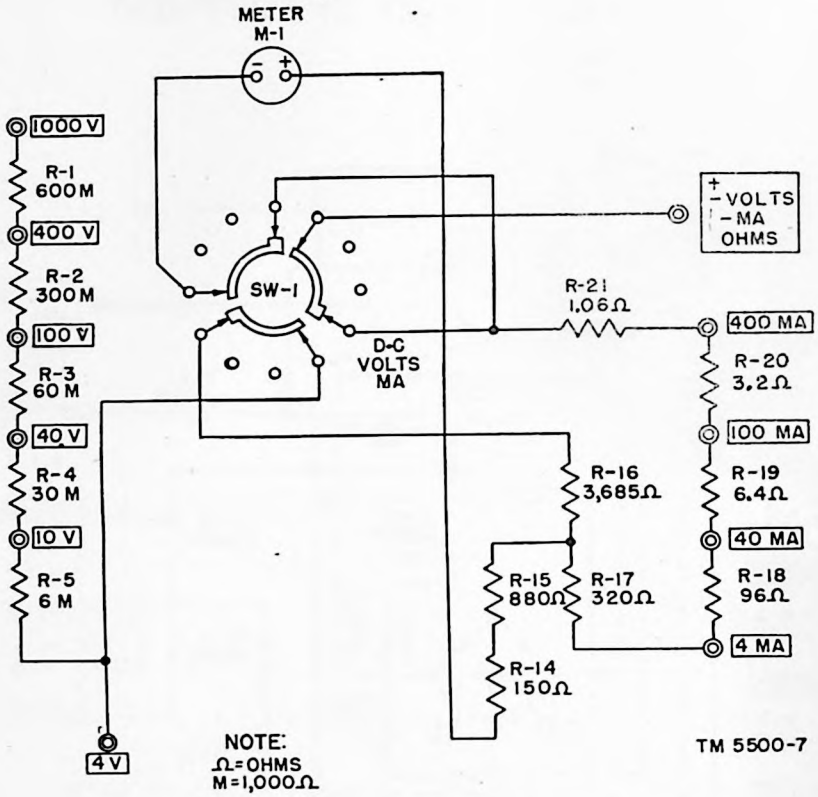


Figure 7. D-c volts—ma circuit, schematic diagram.

a. Milliammeter (fig. 7). When the multimeter is used to measure direct current, the meter is connected to a universal shunt composed of resistors R–21, R–20, R–19, R–18, R–17, R–15, and R–14. R–14 compensates for resistance variations in the circuit due to temperature changes. Taps taken off between the shunt resistors vary the current sensitivity so that current introduced into the appropriate tap may be measured from 1 ma to 400 ma.

b. D–c Voltmeter (fig. 7). When the multimeter is used to measure d-c voltage, a tap of the universal shunt is used to obtain a sensitivity of 1 ma, and resistor R–16 is added to the circuit as the multiplier for

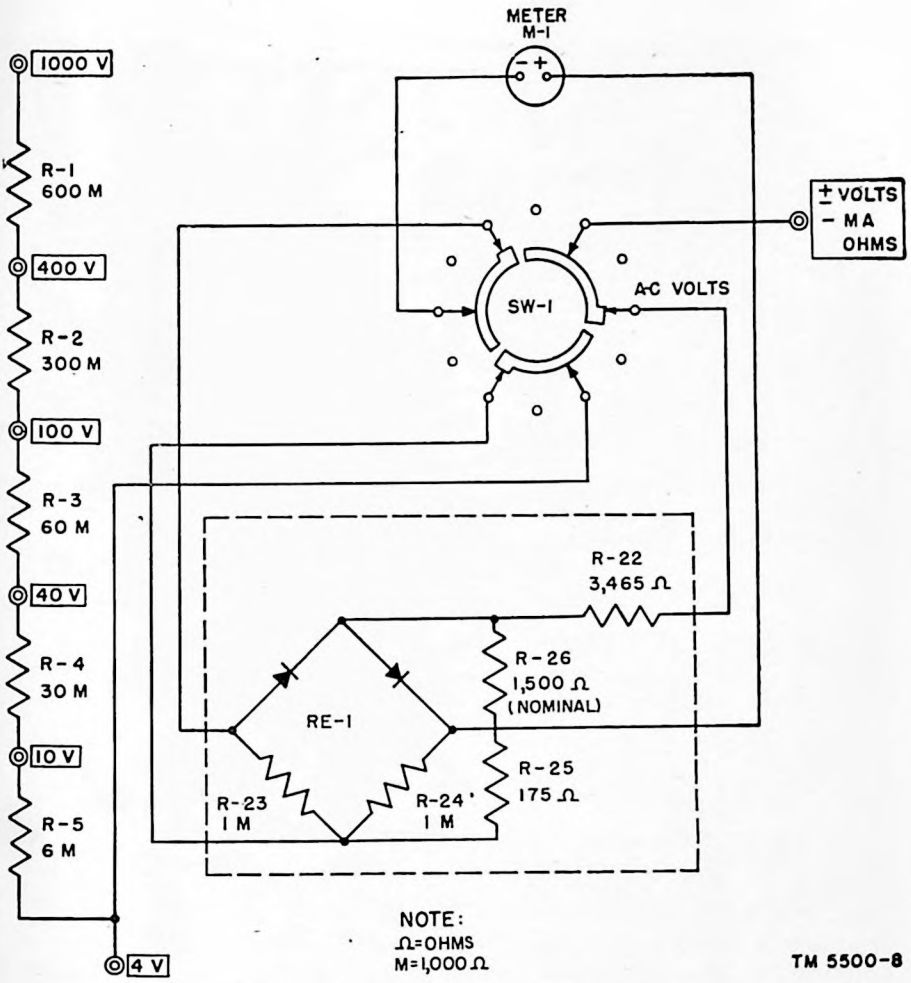


Figure 8. A-c volts circuit, schematic diagram.

the 4V range. Successive addition of resistors R–5, R–4, R–3, R–2, and R–1 permits measurements in the 10V, 40V, 100V, 400V, and 1,000V ranges, respectively.

c. A-C VOLTMETER (fig. 8). When the multimeter is used to measure a-c voltage, the universal shunt is not connected and the meter is used at its capacity of 250 microamperes. A rectifier bridge, consisting of the copper-oxide rectifier RE–1 and resistors R–23 and R–24, is connected across the meter with R–22, which forms the multiplier for the 4V range. The rectifier input is shunted by resistors R–25 and R–26, which are temperature-compensating on a-c voltage measurements and are matched to control the rectifier input. Successive addition of resistors R–5, R–4, R–3, R–2, and R–1 permits measurements in the 10V, 40V, 100V, 400V, and 1,000V ranges, respectively.

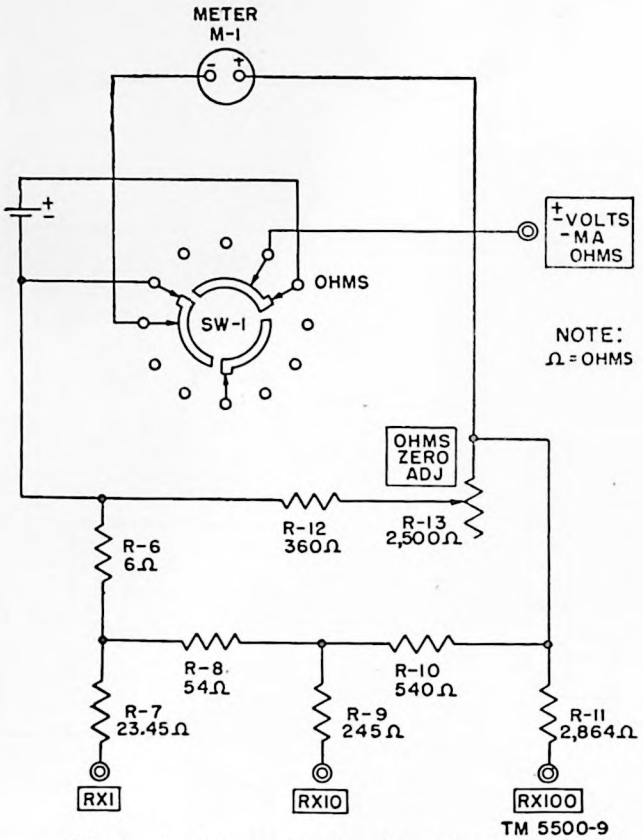


Figure 9. Ohms circuit, schematic diagram.

d. OHMMETER (fig. 9). When the multimeter is used to measure resistance, a shunt composed of resistors R–6, R–8, and R–10 is connected across the meter. One and one-half volts from the battery is applied to the circuit, and additional shunting from resistors R–12 and R–13 adjusts the current through the meter to obtain full-scale needle deflection. The addition of an unknown resistance to the circuit reduces current flow and changes the needle deflection so that the unknown resistance may be measured directly on the meter scale. Resistors R–7, R–9, and R–11 adjust the circuit for correct center-scale readings.

Section IX. TROUBLE-SHOOTING PROCEDURES

30. General

Equipment may fail no matter how carefully it is designed, manufactured, and handled. When failures occur, they must be located and corrected as quickly as possible.

a. REFERENCES. To locate faults quickly, consult the following:

(1) Complete schematic diagram (fig. 6).

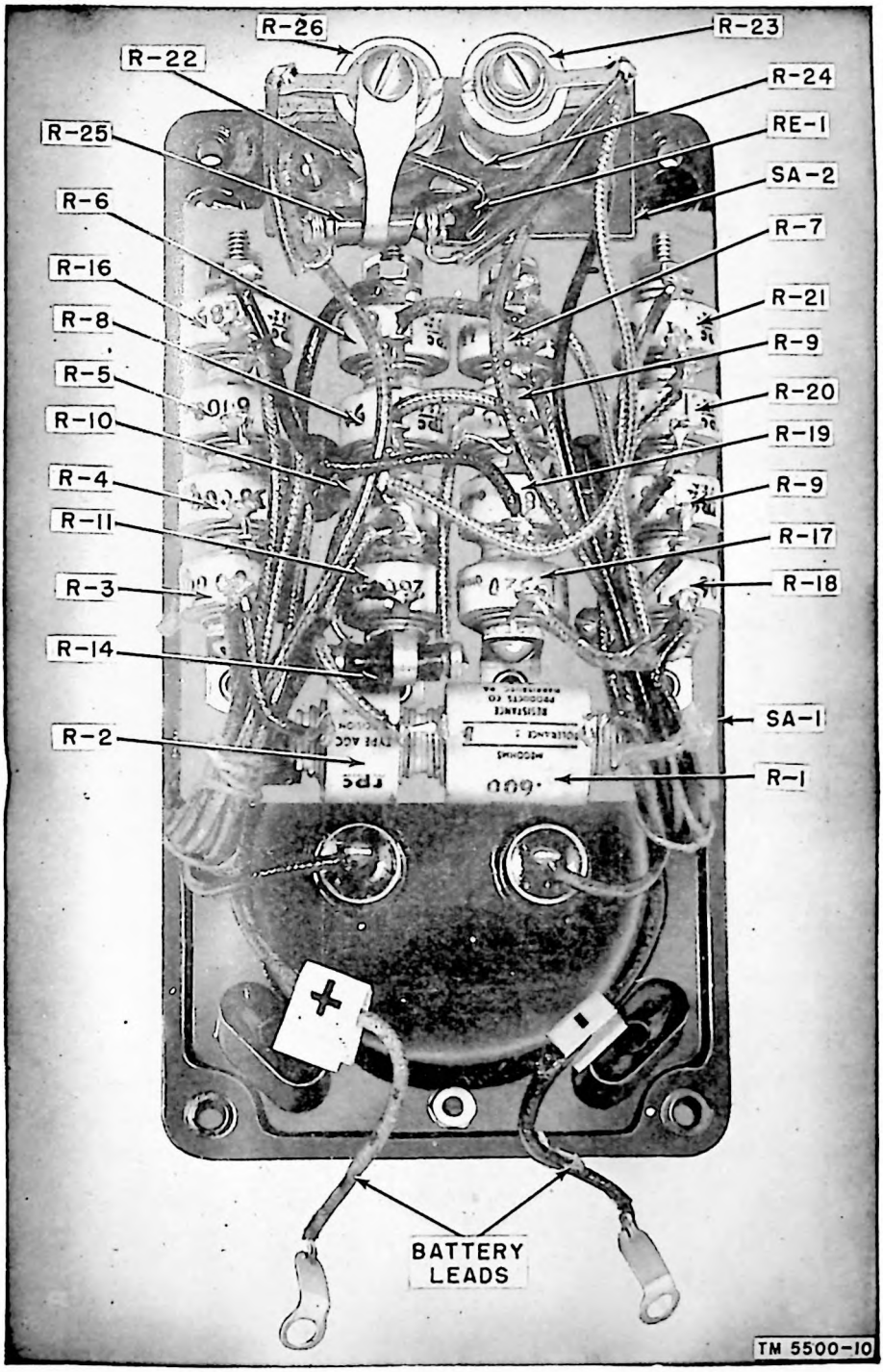


Figure 10. Multimeter subpanel.

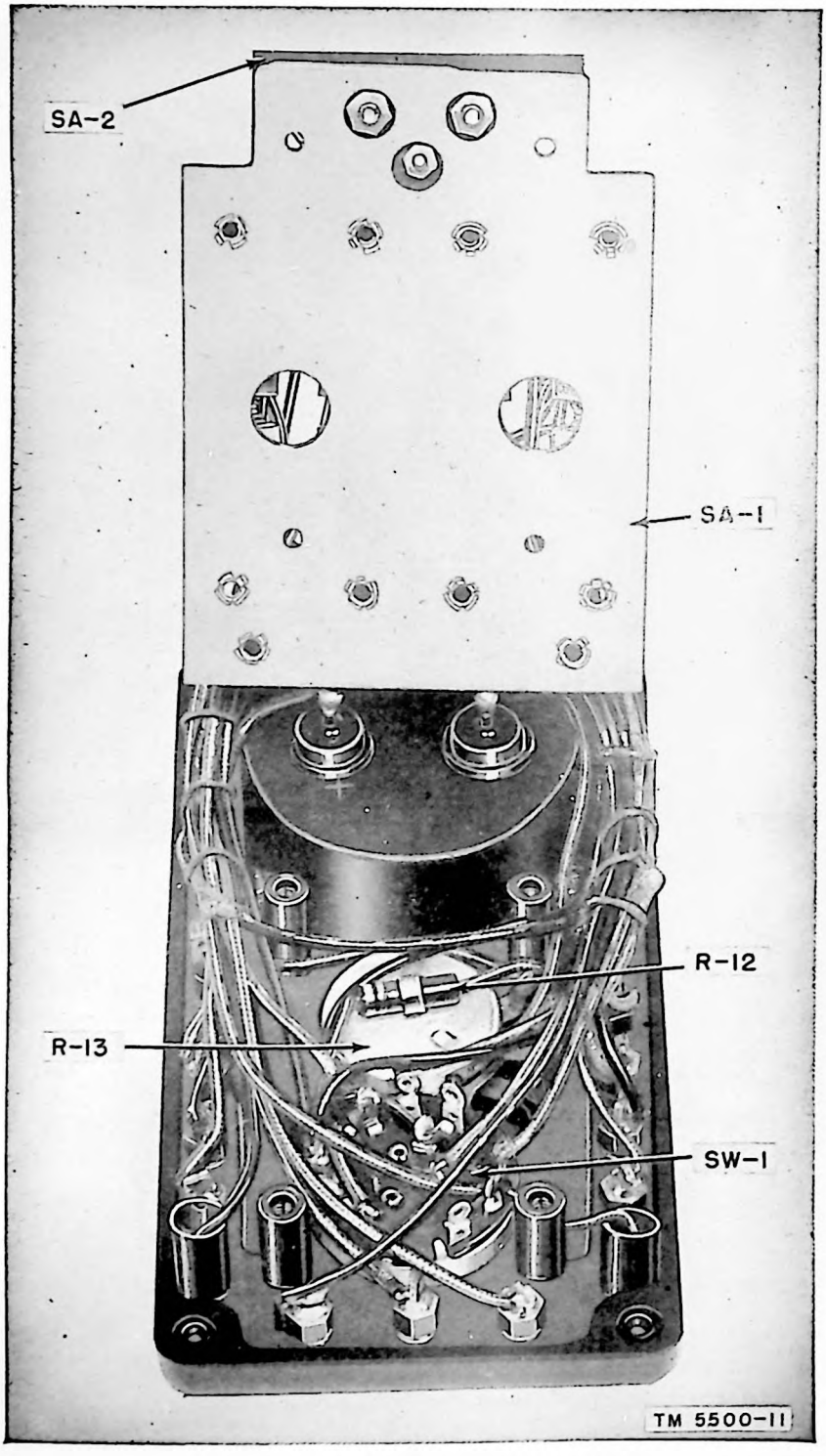


Figure 11. Multimeter, subpanel raised.

(2) Simplified, partial schematic diagrams, by which electrical functioning of circuits can be quickly followed (figs. 7, 8, and 9).

(3) Illustrations, particularly front and back views of the subpanel, which will help in locating and identifying parts (figs. 10 and 11).

b. TROUBLE-SHOOTING STEPS. Sectionalize the fault, tracing it to the circuit responsible for abnormal operation. Then localize the fault, tracing it to the defective part.

31. Meter Test

To test the meter movement, proceed as follows:

a. Remove multimeter panel from case (par. 7*a*, *b*, and *c*).

b. Inspect leads to meter for loose or corroded connections. Disconnect leads from meter terminals.

c. Check resistance between the two disconnected leads. If a short circuit is indicated, test the leads and the selector switches. If leads and switches are normal, proceed with instructions given in *d* below.

d. Connect an 11,700-ohm resistor, a 1.5-volt battery, and the meter in series, observing proper polarity. Be sure that leads have been disconnected from the meter. If the meter does not show half-scale deflection, it is defective and should be replaced.

Caution: Do not use a higher voltage or lower resistance than specified, because the meter may be damaged.

e. The meter should have a millivolt reading of 62.5 mv ± 2 percent and a current sensitivity of 250 microamperes ± 2 percent.

32. Component Failures

a. RESISTORS. Resistors should measure within the tolerances indicated in the identification table of replaceable parts (app. II). Replacement of R–14 is indicated if d-c readings are inaccurate under extreme temperature conditions.

b. RECTIFIER. Failure of rectifier RE–1 will result in partial or no reading for a-c voltage measurements. If replacement of RE–1, R–22, R–25, or R–26 is necessary, subassembly SA–2 must be replaced as a unit. Resistors R–23 and R–24 of subassembly SA–2 may be replaced individually, if necessary. If a-c voltage readings are out of tolerance under extreme temperature conditions, SA–2 must be replaced.

c. RHEOSTAT. If the meter needle jumps or fluctuates as adjustment is made for full-scale reading on resistance measurements, a defective R–13 is indicated. Complete failure of R–13 will result in constant off-scale readings.

d. SWITCH. SW–1, a three-position, three-pole, single-wafer switch, may fail because of dirt, moisture, corrosion, arcing, or wear.

e. JACKS. Individual jack springs may lose tension because of freezing, wear, or overheating during soldering operations.

f. CORDS. Simple continuity checks will determine whether cordage has opened or shorted due to flexing or stress.

33. Trouble-shooting Chart

Symptom	Probable location of fault	Corrective action
1. All meter ranges inaccurate or completely inoperative.	*a.* Defective meter.	*a.* Refer to paragraph 31.
	b. Open test leads.	*b.* Check leads for continuity.
	c. Open switch leads.	*c.* Check wiring.
2. Inaccurate or no reading on one or more d-c voltage ranges.	*a.* Defective switch SW–1.	*a.* Check switch leads or contacts.
	b. Open jack.	*b.* Apply test prods to base of jack on low voltage.
	c. Defective shunt network	*c.* Check R–17, R–18, R–19, R–20, R–21, R–14, and R–15. Replace if necessary.
	d. Defective multiplier resistors.	*d.* Check R–1, R–2, R–3, R–4, R–5, and R–16. Replace if necessary.
3. Inaccurate or no reading on one or more a-c voltage ranges.	*a.* Defective rectifier.	*a.* Replace subassembly SA–2, consisting of R–22, R–23, R–24, R–25, R–26, and RE–1.
	b. Defective multiplier resistors.	*b.* Check R–1, R–2, R3, R–4, R–5, and R–22. Replace if necessary.
4. Inaccurate or no readings on one or more d-c ranges.	*a.* Defective switch SW–1	*a.* Check switch leads or contacts.
	b. Defective shunt network.	*b.* Check R–14, R–15, R–17, R–18, R–19, R–20, and R–21. Replace if necessary.
5. Inaccurate or no reading on one or more resistance ranges.	*a.* Weak battery.	*a.* Replace battery if under 1.25 v.
	b. Defective resistors.	*b.* Check R–6, R–7, R–8, R–9, R–10, and R–11. Replace if necessary.
	c. Defective OHMS ZERO ADJ rheostat.	*c.* Check R–12 and R–13. Replace if necessary.

Section X. REPAIRS

34. Servicing

Servicing and repair of this equipment, other than battery replacement, should be performed only by competent personnel equipped with the necessary tools and instruments. An inexperienced repairman may damage the equipment to such an extent that it will be beyond repair.

35. General Repair

Multimeter TS–297/U is a delicate instrument. Be very careful in removing or replacing defective parts or circuit elements and make every effort to obtain the proper tools before attempting repairs. If possible, make an electrical check of any part that may be defective *before* removing it from the equipment.

a. IDENTIFICATION OF LEADS. Before removing circuit elements to gain access to a defective part, insure proper reinstallation by making a record of the connections to each element and the position of each element.

b. MAKING CONNECTIONS. Some clearances are very small; therefore, be extremely careful in soldering. When replacing leads, use only enough solder to make a secure connection. A slight amount of excess solder dropped accidentally inside the equipment may cause short circuits or other damage. Do not heat a lug or connection more than necessary, since near-by elements may be damaged.

c. REMOVING PARTS. The identification table of replaceable parts will show whether the defective part is individually replaceable or must be replaced as one of a matched set of parts.

(1) If the part is on the subpanel, unsolder it and remove the holding bolts and screws. After the part has been replaced, be sure to resolder connections.

(2) If the part is under the subpanel, remove the four screws that fasten the subpanel to the front panel and lift the subpanel gently upward, tipping it toward the meter. The jacks, rheostat, switch, and rectifier then may be reached easily. To remove the rheostat and switch, loosen the setscrew in the appropriate knob on the panel face and unscrew the nut that holds the rheostat or switch to the back of the panel face. To remove the meter, unscrew the three screws that hold it to the panel face.

36. Unsatisfactory Equipment Report

a. WD AGO FORM 468 (UNSATISFACTORY EQUIPMENT REPORT) FOR EQUIPMENT USED BY THE ARMY. WD AGO Form 468 will be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C., when trouble occurs more often than is normal, as determined by qualified repair personnel.

b. AF FORM 54 (UNSATISFACTORY REPORT) FOR EQUIPMENT USED BY THE AIR FORCE. AF Form 54 will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, in accordance with AF Regulation 15–54.

APPENDIX I

REFERENCES AND ABBREVIATIONS

1. Publications

FM 21–6	List and Index of Department of the Army Publications
TM 1–455	Electrical Fundamentals
TM 11–472	Repair and Calibration of Electrical Measuring Instruments
TM 11–2535	Meter Test Equipment AN/GSM–1
TM 38–650	Basic Maintenance Manual

2. Forms

AF Form 54	(Unsatisfactory Report)
WD AGO Form 468	(Unsatisfactory Equipment Report)

3. Packaging and Packing Instructions

a. Joint Army-Navy Packaging Instructions.

JAN–P–100	General Specifications

b. U. S. Specifications.

100–2E	Marking Shipments by Contractors (and Signal Corps Supplement thereto)
100–14A	Army-Navy General Specification for Packaging and Packing for Overseas Shipment

c. Signal Corps Instructions.

720–7	Standard Pack
726–15	Interior Marking

4. Painting and Preserving

SB 11–76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment
TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment
TB SIG 66	Winter Maintenance of Signal Equipment
TB SIG 75	Desert Maintenance of Ground Signal Equipment
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment

5. Abbreviations

AC, ac ..... alternating current
ADJ ..... adjust
C ..... centigrade
cu in. ..... cubic inch
DB, db ..... decibel
DC, dc ..... direct current
F ..... Fahrenheit
in. ..... inch
lb ..... pound
ma ..... milliampere
mf ..... microfarad
mv ..... millivolt
mw ..... milliwatt
par. ..... paragraph
RX ..... resistance multiplied by
V, v ..... volt

APPENDIX II

IDENTIFICATION TABLE OF REPLACEABLE PARTS

Note. The fact that a part is listed in this table is not sufficient basis for requisitioning the part. Requisitions must cite an authorized basis, such as T/O & E, TE, TA, T/BA, SIG 6, SIG 7, SIG 7–8–10, SIG 10, list of allowances of expendable material, or another authorized supply basis. The applicable Department of the Army Supply Catalog pamphlet for the equipment covered in the manual is listed in paragraph 1 below.

1. Supply Pamphlet

The following information was compiled on 10 May 1948. The appropriate pamphlet of the Department of the Army Supply Catalog for Multimeter TS–297/U is—

Organizational Maintenance Allowances, and Field and Base Maintenance Stokage Guide, SIG 7 & 8 TS–297/U (when published).

For an index of available catalog pamphlets, see the latest issue of Supply Catalog SIG 1 & 2.

2. Identification Table of Replaceable Parts for Multimeter TS–297/U

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
Fig. 1	MULTIMETER TS–297/U: portable; meter ranges v, AC, DC 0/4/10/40/100/400/1,000; ma DC 0/4/40/100/400; ohms 0/1,000/10,000/100,000; aluminum case 3⅛″ wd x 6″ lg x 3½″ wd w/hinged lid.	Multirange test instrument for measuring voltage, current, and resistance.	3F4325–297
Fig. 2	CLIP: alligator; for test lead; steel 2″ lg; Mueller Elec #60.	To attach test prods to circuit tested (fig. 2).	3Z1087

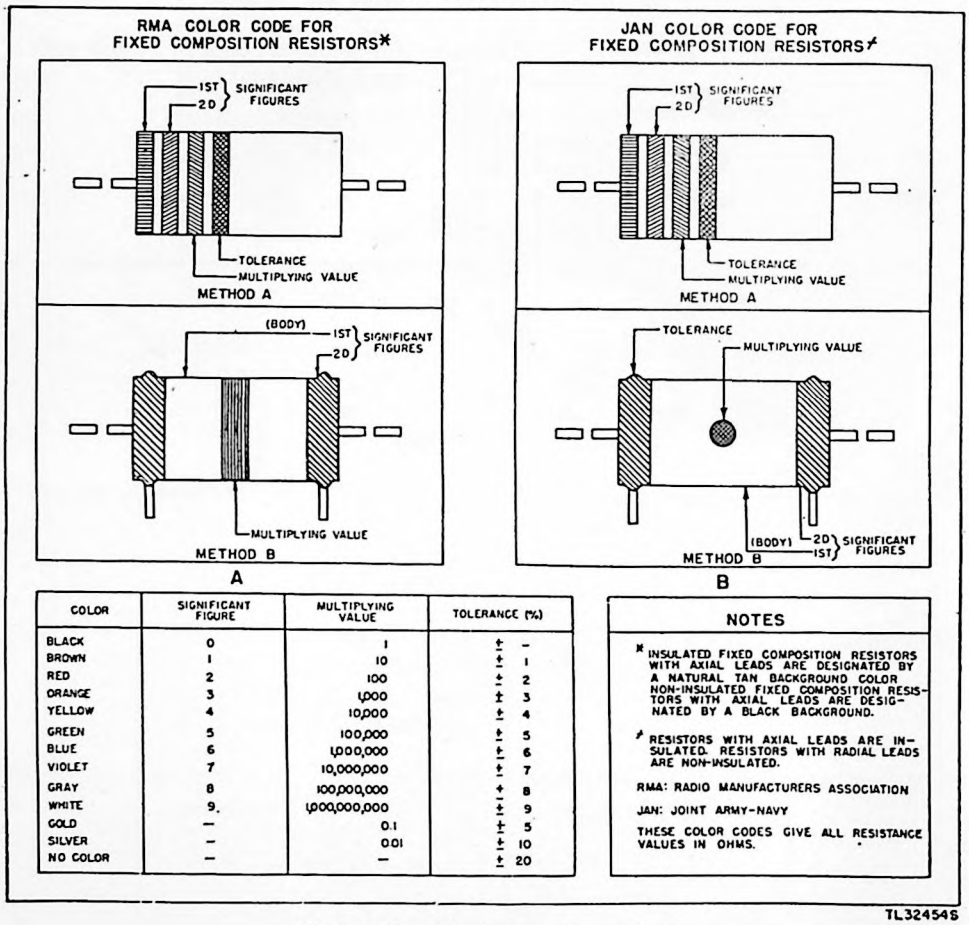
Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
Fig. 2	CORD CX–468/U: 2 cond; rubber-covered; 4 ft; consists of Sig C Cordage CO–119 w/Sig C Plug PL–55 one end, one red and one black insulated phone tip plug other end.	Used to measure current or voltage accessible through a jack.	3E6000–468–48
K–1, K–2	KNOB, round: black bakelite; for ¼" diam shaft; single #8–32 setscrew; 11/16" diam x 13/32" h; Harry Davies Mold #1400.	To position function switch and ohms-adjust control (fig. 3).	2Z5821–4.1
	LEAD SET, test: Army-Navy Cord CX–529/U; 4 ft lg excluding terminations; one end ⅞" lg tip, other end 1 13/32" lg tip w/Mueller Elec #60 alligator clip; consists of 2 leads, 1 red, 1 black.	Used to connect multimeter with circuit or component to be measured.	3E6000–529
M–1	METER, multiscale: DC; range 4/10 linear scale, 4/10 AC, 1/1,000 ohms; round metal case, flush mounting; HS; barrel 2.15" diam with 2.695" diam flange; depth behind panel 1.063"; calibrated for nonmagnetic panel; 20 scale division, black and red numerals on white background; Marion Elec Instr #HM 2½.	Indicates voltage, direct-current, or resistance reading (fig. 3).	3F1710E.2
R–21	RESISTOR, fixed: wirewound; 1.06 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B1R060F.	Universal shunt (fig. 10).	3RB2–1060
R–20	RESISTOR, fixed: wirewound; 3.2 ohms ±1%; ¼ w at 85° C; 15/32" lg x ¾" diam; JAN type RB10B3R200F.	Universal shunt (fig. 10).	3RB2–3200
R–6	RESISTOR, fixed: wirewound; 6 ohms ±1%; ¼ w at 85° C; 15/32" lg x ¾" diam; JAN type RB10B6R000F.	Shunt used in measuring resistance (fig. 10).	3RB2–6000

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
R–19	RESISTOR, fixed: wirewound; 6.40 ohms ±1%; ¼ w at 85° C; 15/32" lg x ¾" diam; JAN type RB10B6R400F.	Universal shunt (fig. 10).	3RB2–6400
R–7	RESISTOR, fixed: wirewound; 23.45 ohms ±1%; ¼ w at 85° C; 15/32" lg x ¾" diam; JAN type RB10B23R45F.	To adjust center-scale readings (fig. 10).	3RB3–2345
R–8	RESISTOR, fixed: wirewound; 54 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B54R00F.	Shunt used in measuring resistance (fig. 10).	3RB3–5400
R–18	RESISTOR, fixed: wirewound; 96 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B96R00F.	Universal shunt (fig. 10).	3RB3–9600
R–14	RESISTOR, fixed: compensating; nominal value 150 ohms ±10% at 25° C; ½ w; ⅛" diam x ⅝" lg; Globar #304B.	Universal shunt (fig. 10).	3Z6015–94
R–9	RESISTOR, fixed: wirewound; 245 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B245R0F.	To adjust center-scale readings (fig. 10).	3RB4–2450
R–17	RESISTOR, fixed: wirewound; 315 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B315R0F.	Universal shunt (fig. 10).	3RB4–3150
R–12	RESISTOR, fixed: composition; 360 ohms ±5%; ½ w; max body dimen 0.468" lg x 0.249" diam; JAN type RC20BF361J.	Shunt through meter to obtain full-scale needle deflection in measuring resistance (fig. 11).	3RC20BF361J
R–10	RESISTOR, fixed: wirewound; 540 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B540R0F.	Shunt used in measuring resistance (fig. 10).	3RB4–5400
R–15	RESISTOR, fixed: wirewound; 880 ohms ±1%, ¼ w; 15/32" lg x ¾" diam; JAN type RB10B880R0F.	Universal shunt (fig. 10).	3RB4–8800

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
R–23, R–24	RESISTOR, fixed: wirewound; 1,000 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B10000F.	Rectifier bridge (fig. 10).	3RB5–1000
R–13	RESISTOR, variable (potentiometer): metalized; 2,500 ohms ±20%; ⅓ w; 3 solder lug term; case 1⅛" diam x 17/32" d, enclosed case; shaft round ¼" diam x ⅜" lg; linear taper; bushing ⅜"–32 x ¼"; IRC #DS.	Shunt through meter; OHMS ZERO ADJ rheostat (fig. 11).	3Z7325–26
R–11	RESISTOR, fixed: wirewound; 2,864 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B28640F.	To adjust circuit for correct center-scale readings (fig. 10).	3RB5–2864
R–16	RESISTOR, fixed: wirewound; 3,686 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B36860F.	Multiplier for 4V range in measuring d-c voltage (fig. 10).	3RB5–3686
R–5	RESISTOR, fixed: wirewound; 6,000 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B60000F.	Multiplier for 10V range (fig. 10).	3RB5–6000
R–4	RESISTOR, fixed: wirewound; 30,000 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B30001F.	Multiplier for 40V range (fig. 10).	3RB6–3000.1
R–3	RESISTOR, fixed: wirewound; 60,000 ohms ±1%; ¼ w; 15/32" lg x ¾" diam; JAN type RB10B60001F.	Multiplier for 100V range (fig. 10).	3RB6–6000
R–2	RESISTOR, fixed: wirewound; 300,000 ohms ±1%; ⅓ w; ⅝" lg x 13/16" diam; JAN type RB11B30002F.	Multiplier for 400V range (fig. 10).	3RB7–3000
R–1	RESISTOR, fixed: wirewound; 600,000 ohms ±1%; ½ w; 1" lg x ⅝" diam; Resistance Products type #AGF.	Multiplier for 1,000V range (fig. 10).	3Z6760–12

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
SA–2	RESISTOR ASSEMBLY, fixed: five wire-wound resistors and one metallic rectifier mtd on bakelite strip; consists of resistors R–22, R–23, R–24, R–25, R–26, and RE–1; ⅞″ lg x 2″ wd x 1¼″ h overall; Chi Ind Instr dwg #TS–297/U–26.	Rectifier subassembly (fig. 10).	
SW–1	SWITCH, rotary: 3 pole, 3 position, 1 sect; steel body, phenolic wafer; 1¼″ diam x 13/16″ d behind panel; nonshorting contacts; single hole mtg; bushing ⅜″–32; Mallory #3100 small.	OHMS AC DC switch (fig. 11).	3Z9826–4.15

RESISTOR COLOR CODES



COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)
BLACK	0	1	± –
BROWN	1	10	± 1
RED	2	100	± 2
ORANGE	3	1,000	± 3
YELLOW	4	10,000	± 4
GREEN	5	100,000	± 5
BLUE	6	1,000,000	± 6
VIOLET	7	10,000,000	± 7
GRAY	8	100,000,000	± 8
WHITE	9	1,000,000,000	± 9
GOLD	–	0.1	± 5
SILVER	–	0.01	± 10
NO COLOR	–	–	± 20

NOTES

* INSULATED FIXED COMPOSITION RESISTORS WITH AXIAL LEADS ARE DESIGNATED BY A NATURAL TAN BACKGROUND COLOR NON-INSULATED FIXED COMPOSITION RESISTORS WITH AXIAL LEADS ARE DESIGNATED BY A BLACK BACKGROUND.

≠ RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.

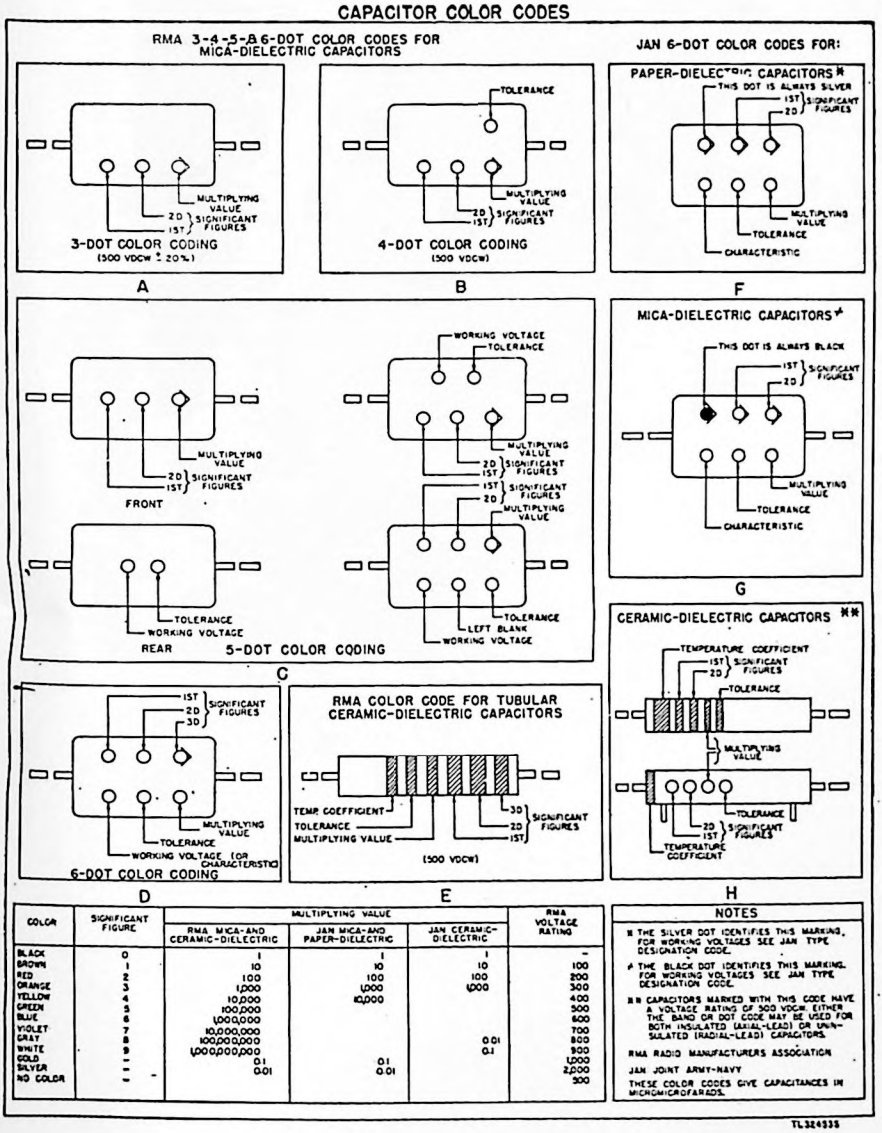
RMA: RADIO MANUFACTURERS ASSOCIATION

JAN: JOINT army-navy

THESE COLOR CODES GIVE ALL RESISTANCE VALUES IN OHMS.

TL32454S

Figure 12. Resistor color codes.



COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE: RMA MICA-AND CERAMIC-DIELECTRIC	MULTIPLYING VALUE: JAN MICA-AND PAPER-DIELECTRIC	MULTIPLYING VALUE: JAN CERAMIC-DIELECTRIC	RMA VOLTAGE RATING
BLACK	0	1	1	1	-
BROWN	1	10	10	10	100
RED	2	100	100	100	200
ORANGE	3	1,000	1,000	1,000	300
YELLOW	4	10,000	10,000		400
GREEN	5	100,000			500
BLUE	6	1,000,000			600
VIOLET	7	10,000,000			700
GRAY	8	100,000,000		0.01	800
WHITE	9	1,000,000,000		0.1	900
GOLD	-	0.1	0.1		1,000
SILVER	-	0.01	0.01		2,000
NO COLOR	-	-			300

NOTES

THE SILVER DOT IDENTIFIES THIS MARKING. FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

* THE BLACK DOT IDENTIFIES THIS MARKING. FOR WORKING VOLTAGES SEE JAN TYPE DESIGNATION CODE.

CAPACITORS MARKED WITH THIS CODE HAVE A VOLTAGE RATING OF 500 VDCW. EITHER THE BAND OR DOT CODE MAY BE USED FOR BOTH INSULATED (AXIAL-LEAD) OR UNINSULATED (RADIAL-LEAD) CAPACITORS.

RMA RADIO MANUFACTURERS ASSOCIATION

JAN JOINT ARMY-NAVY

THESE COLOR CODES GIVE CAPACITANCES IN MICROMICROFARADS.

TL 324335

Figure 13. Capacitor color codes.

U. S. GOVERNMENT PRINTING OFFICE: 1948—797944

THIS SUPPLEMENT WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL DEPARTMENT OF THE ARMY PUBLICATION.

SUPPLEMENT

24 APRIL 1952

SUPPLEMENT TO TM 11-5500 MULTIMETER TS-297/U

The following information, published on Order Nos. 2978-Phila-52, 2977-Phila-52, 3061-Phila-52, and 2982-Phila-52, supplements TM 11-5500, August 1948.

Personnel using this equipment and having custody of this technical manual will enter suitable notations beside each affected paragraph and figure in the technical manual to indicate the presence of this supplementary information.

Note: Make the following changes in the manual:

Change the switch panel marking "OHMS AC DC" to read: OHMS ACV DCV/MA.

Change the ohms-adjust knob panel marking "OHMS ZERO ADJ" to read: OHMS ZERO ADJUST.

Change the common-jack panel marking "±VOLTS -MA OHMS" to read: OHMS -DCV -MA ACV.

Change Cord CX-529/U to read: Test Lead Set CX-1331/U.

Page 2. Par. 3. In subparagraph *a*, delete the second and third items from the table and substitute the following:

Quantity	Name of component	Dimensions (in.)				Unit weight (lb.)	Unit volume (cu. in.)
		Height	Width	Depth	Length		
1	Test Lead Set CX-1331/U	.....	.....	.....	48	.....	.....
1	Cord CX-1332/U	.....	.....	.....	72	.....	.....

Page 2. Par. 4. Delete the text of paragraph 4, and substitute the following: Packaged for export shipment (fig. 4), Multimeter TS-297/U is contained in a heavy cardboard carton 8½ inches long, 6 inches wide, and 4¾ inches high. The volume of the carton is 242¼ cubic inches, and the shipping weight is 3 pounds, 13 ounces.

Page 2. Par. 5. Make the following changes in paragraph 5:

In subparagraph *a*, line 2, change "black" to read: gray.

Delete subparagraph (1)(*a*), and substitute the following:

(*a*) *Meter dial.* The white meter dial is marked with three scales calibrated along parallel arcs. The upper scale, labeled OHMS, is printed in green. Divisions are marked above the scale from zero to infinity by the numerical designations: 0, 5, 10, 20, 30, 50, 100, 200, 500, 1,000, and ∞. The center scale, labeled DC, is printed in black and graduated for the measurement of d-c volts and d-c milliamperes. Every fifth division is marked below the scale; markings are in alternative series of numerals: 0 (common); 10, 20, 30, 40; and 25, 50, 75, 100. The lower scale, labeled ACV, is printed in purple-blue and is graduated for the measurement of a-c volts. Every fifth division is marked below the scale; markings are by alternative series of numerals 0 (common); 10, 20, 30, 40; and 25, 50, 75, 100.

Add the following to subparagraph *a*(1)(*c*):

A green, black, or purple-blue dot adjacent to a jack indicates the color of the associated meter scale or scales.

In subparagraph *b*, line 4, delete "(Mueller No. 60)."

Page 4. Par. 5. Make the following changes in subparagraph *c*:

Change the heading to read: Cord CX-1332/U.

In the first line, change "Cord CX-468/U" to read: Cord CX-1332/U.

In the last line, change "Plug PL-55" to read: Plug PJ-055B.

Page 3. Fig. 2. Change "Cord CX-468/U" to read: Cord CX-1332/U.

Page 4. Fig. 3. Delete figure 3 and substitute the following:

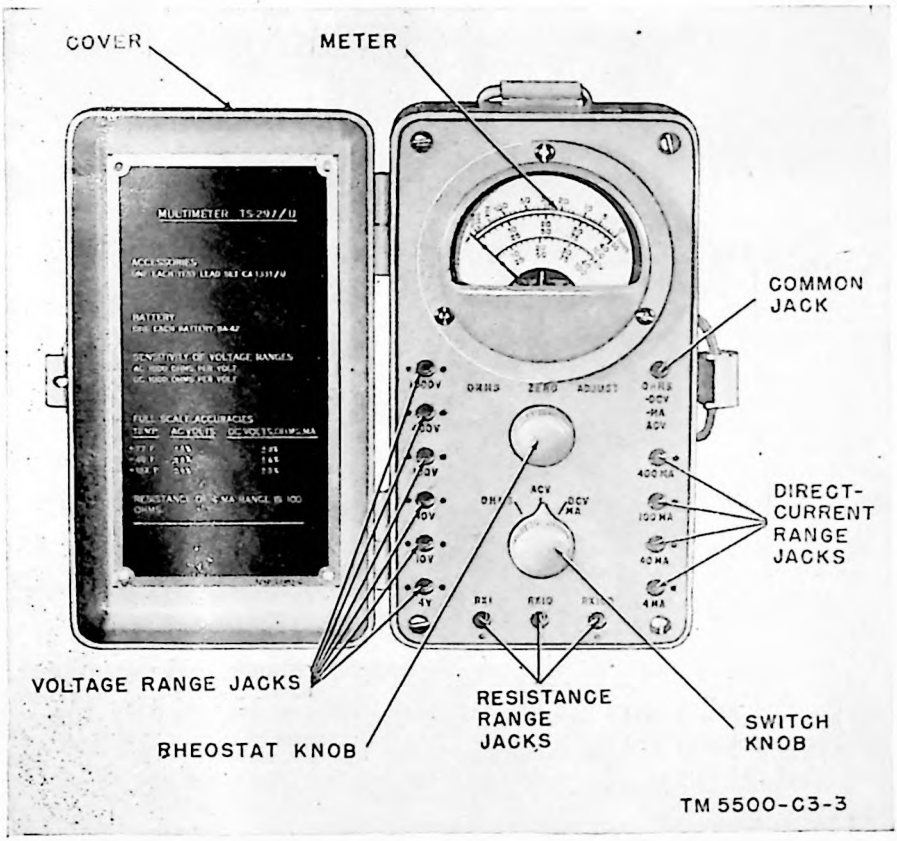


Figure 3. Multimeter, view of panel face.

Page 5. Fig. 4. Delete figure 4, and substitute the following:

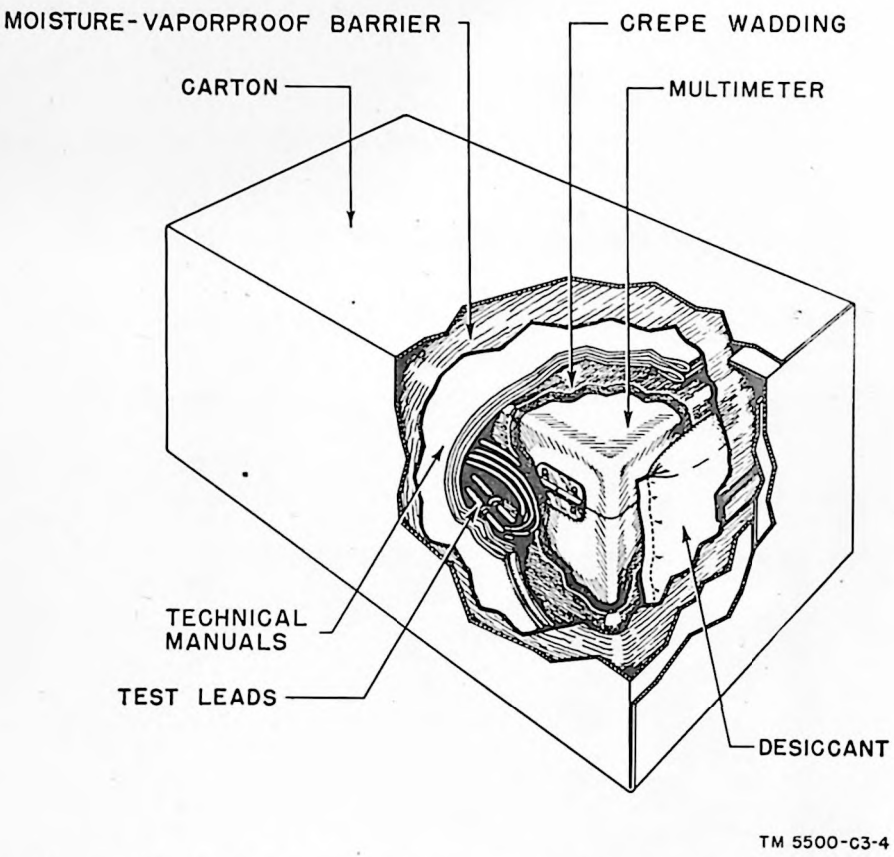


Figure 4. Multimeter TS-297/U, cutaway view showing packaging detail.

Page 5. Par. 6. Make the following changes in paragraph 6:

Delete subparagraphs *a*(1) through (4), and substitute the following:

(1) Open the carton, and remove the multimeter package.

(2) Cut off the sealed edge of the moisture-vaporproof barrier bag, and remove the multimeter, TM 11-5500, the cord set, and the desiccant. If cut carefully, the barrier bag may be used again.

(3) Remove all tape and cushioning material.

In subparagraph *b*(1) change "and cords" to read: test leads and alligator clips.

Page 8. Par. 12. Make the following changes in paragraph 12:

In line 1, change "Cords CX-529/U and CX-468/U" to read: Test Lead Set CX-1331/U and Cord CX-1332/U.

In lines 2 and 3, change "Cord CX-529/U" to read: Test Lead Set CX-1331/U.

In line 4, change "Cord CX-468/U" to read: Cord CX-1332/U.

In line 6, change "Plug PL-55" to read: Plug PJ-055B.

Page 9. Par. 13. In subparagraph *c*, line 1, change "AC, and DC" to read: ACV, and DCV.

Page 9. Par. 14. Delete subparagraph *a*, and reletter subparagraph *b* through *g* to read respectively: *a*, *b*, *c*, *d*, *e*, and *f*.

Page 9. Par. 15. Make the following changes in paragraph 15:

In subparagraph *a*, line 1, change "AC" to read: ACV.

In line 2, change "DC" to read: DCV.

In subparagraph *d*, line 1, change "DC" to read: black DC.

Change "AC" to read: purple-blue ACV.

Page 10. Par. 16. Make the following changes in paragraph 16:

In subparagraph *a*, change "DC" to read: DCV.

In subparagraph *d*, change "DC" to read: black DC.

Page 12. Par. 18. Make the following changes in paragraph 18:

In subparagraph *a*, change "AC" to read: ACV.

In subparagraph *c*, change "red" to read: purple-blue.

Page 14. Par. 23. Make the following changes in paragraph 23:

In subparagraph *a*(1), line 2, change "Allen wrench" to read: screw driver.

In subparagraph *a*(5), change "white or cream wiping enamel" to read: wiping enamel of the appropriate color.

Add the following to subparagraph *b*(1):

If a wire of Test Lead Set CX-1331/U becomes defective near the ends, cut off the defective section, remove the tip, and assemble it to the undamaged wire.

Page 15. Par. 24. Make the following changes in paragraph 24:

In subparagraph *b*(1), change "three" to read: seven.

In subparagraph *b*(4), change second sentence to read:

Be sure that the red wire is attached to the + end of battery holder and the black wire to the — end.

In subparagraph *b*, change subparagraph number "(5)" to read: (6), and subparagraph number "(6)" to read: (5), and transpose positions of these two subparagraphs.

Page 19. Fig. 6. Change the value of resistor R12 to read: 220Ω.

Page 22. Fig. 9. Change the value of R12 to read: 220Ω.

Page 23. Fig. 10. Add the following after the caption:

(*Change R19 to R15; change R9 above R17 to R19.*)

Page 31. App II. Delete appendix II and substitute the following:

APPENDIX II

IDENTIFICATION TABLE OF PARTS

Note. The following is an identification table of parts for Multimeter TS-297/U (Signal Corps stock No. 3F4325-297). The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as a specific T/O & E, T/A, Sig 7-8-10, SIG 10, list of allowances of expendable material, or another authorized supply basis. The Department of the Army Supply Catalog applicable to the equipment covered in this manual is SIG 7 & 8-TS-297/U. For an index of available supply catalogs, in the Signal portion of the Department of Army Supply Catalog, see the latest issue of SIG 1, Introduction and Index.

Identification Table of Parts

Fig. No. and ref symbol	Name of part and description	Function of part	Signal Corps stock No.
Fig. 2	CLIP: alligator; for test lead; steel, bonderized jaw, black bakelite ins sleeve; 13/32" h x 5/16" wd x 2¼" lg; slides over test prod; ⅜" jaw opening.	Terminates test lead; provides means of connecting test lead to circuit under test.	2Z2708.28
Fig. 2	CLIP: alligator; for test lead; steel, bonderized jaw, red bakelite ins sleeve; 13/32" h x 5/16" wd x 2¼" lg; slides over test prod; ⅜" jaw opening.	Terminates test lead; provides means of connecting test lead to circuit under test.	2Z2712.188
	CONTACT, connector: insert for pin jack.	Receives and connects test cord to circuit.	2Z3193-125
Fig. 2	CORD: 2 cond; rubber covered; 72" lg; c/o Sig C Cordage CO-144, w/Sig C Plug PJ-055B at one end and 2 test prods at other end, AN Cord CX-1332/U.	Used to measure current or voltage accessible through a jack.	3E6000-1332.1
Fig. 3	KNOB: round w/pointer; for ¼" dia shaft; single #8-32 setscrew; 11/16" wd x 13/16" lg x 13/32" h o/a; shaft hole ¼" d.	Used to position function switch.	2Z5822-710
Fig. 3	KNOB: round w/o pointer; for ¼" dia shaft; single #8-32 setscrew; 11/16" wd x 13/16" lg x 13/32" h o/a; shaft hole ¼" d.	Used to position OHMS ZERO ADJUST control.	2Z5822-709
Fig. 2	LEAD SET, test: AN Test Lead Set CX-1331/U.	Used to connect multimeter with circuit or component to be measured.	3E6000-1331.1

Identification Table of Parts (cont'd)

Fig. No. and ref symbol	Name of part and description	Function of part	Signal Corps stock No.
M1 (fig. 3)	METER, multiscale: dc; range 40/100 linear scale, 40/100 ac, 1/1000 ohms; round metal case, flush mounting; HS; calibrated for nonmagnetic panel; 20-scale divisions; black, green, and purple-blue numerals on white background.	Indicates current, voltage, or resistance reading.	3F3299-12.1
SA1 (fig. 3)	PANEL, blank: for mtg parts of unit.	Used as mounting for electrical parts.	2Z6960-106
SA2 (fig. 10)	RECTIFIER SUBASSEMBLY: four wire-wound and one temperature-compensating resistor and one metallic rectifier mounted on bakelite strip; consists of resistors R22, R23, R24, R25, R26, and rectifier RE1.	Restifier subassembly.	3Z6963-2
R14 (fig. 10)	RESISTOR, fixed: compensating; nominal value 150 ohms ±10% at 25° C; ½ w.	Compensates for resistance variations in circuit due to temperature variations.	3Z6015-94
R12 (fig. 11)	RESISTOR, fixed: composition, 220 ohms, ±10%; ½ w; JAN type RC20BF221K.	Shunt in ohmmeter circuit to obtain full-scale needle deflection.	3RC20BF221J
R21 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 1.06 ohms ±1%; ¼ w; 2 solder lug term.	Universal shunt on d-c readings.	3Z5991F6-3
R20 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 3.2 ohms ±1%; ¼ w; 2 solder lug term.	Universal shunt on d-c readings.	3Z59993B
R6 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 6 ohms ±1%; ¼ w; 2 solder lug term.	Shunt used in measuring resistance.	3Z5996-38

Identification Table of Parts

Fig. No. and ref symbol	Name of part and description	Function of part	Signal Corps stock No.
R19 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 6.40 ohms ±1%; ¼ w; 2 solder lug term.	Universal shunt on d-c readings.	3Z5996D4
R7 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 23.45 ohms ±1%; ¼ w; 2 solder lug term.	Used to adjust ohmmeter circuit for center scale readings.	3Z6002C3-12
R8 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 54 ohms ±1%; ¼ w; 2 solder lug term.	Shunt used in measuring resistance.	3Z600504-2
R18 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 96 ohms ±1%; ¼ w; 2 solder lug term.	Universal shunt on d-c readings.	3Z6009F6-1
R9 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 245 ohms ±1%; ¼ w; 2 solder lug term.	Adjusts ohmmeter circuit for correct center scale readings.	3Z6024E5-4
R17 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 320 ohms ±1%; ¼ w; 2 solder lug term.	Universal shunt on d-c readings.	3Z6032-5
R10 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 540 ohms ±1%; ¼ w; 2 solder lug term.	Shunt used in measuring resistance.	3Z6054-2
R15 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 880 ohms ±1%; ¼ w; 2 solder lug term.	Universal shunt on d-c readings.	3Z6088-1
R23, R24 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 1000 ohms ±1%; ¼ w; 2 solder lug term.	Used with RE1 to form rectifier bridge.	3Z6100-268
R11 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 2864 ohms ±1%; ¼ w; 2 solder lug term.	Used to adjust ohmmeter circuit for correct center scale readings.	3Z6280-9

Identification Table of Parts (cont'd)

Fig. No. and ref symbol	Name of part and description	Function of part	Signal Corps stock No.
R16 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 3686 ohms ±1%; ¼ w; 2 solder lug term.	Multiplier for 4-volt range for measuring d-c voltage.	3Z6368
R5 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 6000 ohms ±1%; ¼ w; 2 solder lug term.	Multiplier for 10-volt range.	3Z6560-78
R4 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 30,000 ohms ±1%; ¼w; 2 solder lug term.	Multiplier for 40-volt range.	3Z6630-103
R3 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 60,000 ohms ±1%; ¼ w; 2 solder lug term.	Multiplier for 100-volt range.	3Z6660-44
R2 (fig. 10)	RESISTOR, fixed: wire-wound, noninductive; 300,000 ohms ±1%; 1/3 w; 2 solder lug term.	Multiplier for 400-volt range.	3Z6730-45
R1 (fig. 10)	RESISTOR, fixed: wire-wound, 600,000 ohms ±1%; ½ w; 2 solder lug term.	Multiplier for 1,000-volt range.	3Z6760-12
R13 (fig. 11)	RESISTOR, variable: potentiometer; composition; 2500 ohms ±20%; 1/3 w; 3 solder lug term; inclosed case.	Shunt across meter; OHMS ZERO ADJUST rheostat.	3Z7325-26
SW1 (fig. 11)	SWITCH, rotary: 3 poles, 3 positions, 1 sect; steel body, nonshorting contacts; single hole mtg.	OHMS ACV DCV/MA switch.	3Z9826-4.15